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Plating

The MONTHLY REVIEW

Published by the

American Electro-Platers' Society

A SOCIETY FOR THE ADVANCEMENT
OF THE
SCIENCE OF ELECTROPLATING

SEPTEMBER, 1933

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Greetings!

Every new and constructive move is just so much more help in the Nation's progress back to normal. And so we use this first issue of this publication for a greeting and a promise.

During the past three years the development on new, better and lower cost methods of pickling, plating and finishing has taken much of our time.

In future months, in this space, we will tell you about recent developments in cadmium plating, electrolytic pickling, new anodes, progress in compositions, cleaners and buffs.

In the meantime, be assured that our entire organization is at your disposal to help you lower your costs and improve your product.

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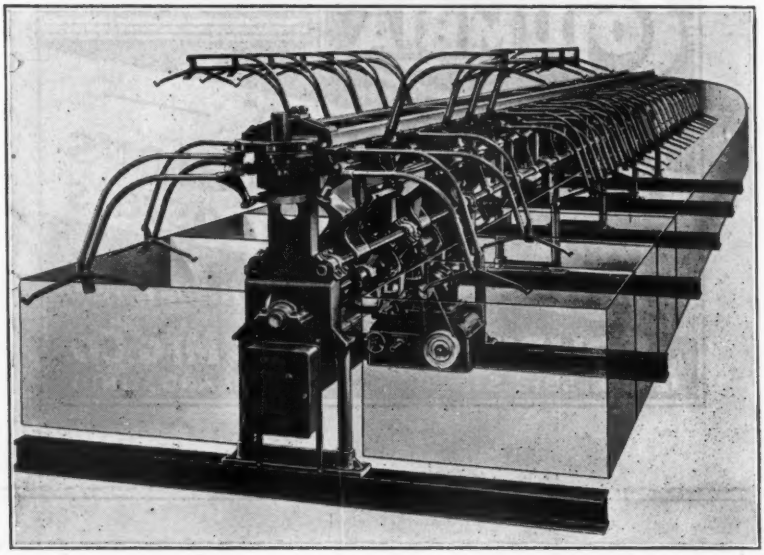

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MONTHLY REVIEW

Published by the

American Electro-Platers' Society

Publication and Editorial Office
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VOL. XX SEPTEMBER, 1933 No. 1

EDITORIAL

We present to our readers for the first time a *Monthly Review* with advertising.

We are encouraged by the response of our advertisers and feel sure we will achieve our object of making the publication self supporting by this means after our plans start working. We must sell ourselves to the public as an organization worthy of their support, for by this alone can we hope for continued success in this new venture.

The members of the Electro-Platers' Society are asked to show their appreciation of those who have given their support, by purchasing their polishing and plating room supplies from the firms placing their advertisements in the Review. A reciprocal agreement that should react to the benefit of both the advertiser and the A. E. S.

The job before us can be made easy if each member would consider himself an advertising agent, ask the supply house representative if his advertisement is in the Review when he seeks your business, tell him the Platers' Society has advertising to sell. Explain to him our program for the coming year and assure him before he leaves that his company's advertisement in the Review is like an N. R. A. sign in the grocery store window.

There seems to be a change taking place all around us. In our industrial life we are faced with changes that would have seemed impossible a few months ago. The plating business must keep up with the new order of things. We have in the September issue taken a step forward which should help us financially. We will be compelled to give our readers and advertisers a better publication even if we have to forget past practices and customs. More up to the minute papers for publication amongst our

technical and practical friends in the trade will be required and our branches must get all papers read at their meetings in for publication.

Our organization, as a whole, must face the new conditions with more determination and vigor. Let's broaden our vision, and include in our membership all who make plating their means of livelihood. Lacquer workers and enamelers should be invited to join with us, inasmuch as the foreman plater has in many plants the supervision over both these latter departments. The plant chemists and those who are giving all their time to research would lend considerable prestige to an organization of this kind and should be included.

Our task, then, is to bring these various groups together under one head. Others have succeeded in combining forces that are so closely allied. The A. E. S. must take the initiative in forming such a union, before others step in ahead of us and wean them away.

EFFECT OF THE DEPRESSION ON THE A. E. S.

By H. A. Gilbertson, Secretary-Treasurer

Our Editor has asked me to write an article for this month's "Review" so I will write something on which I am most familiar with in the work of the A. E. S. I will endeavor to answer the following questions:

What is the effect of the depression on the A. E. S.?

Does our Constitution provide for such a condition?

What will the ultimate outcome be?

The full weight of the depression hit us this quarter. Forty-seven members were suspended and three members resigned. Such a drop in membership, in view of the large losses sustained last year is alarming and demands serious thought. How long can the society endure under such circumstances?

The reason for our heavy loss in membership is due to the incomes of our members being reduced to such an extent that they are barely earning enough for their support, that is, speaking of our average member. Then there are those members who have been unemployed for a long time. The effect of this condition has been to weaken our Branches financially. Those Branches which had balances in their treasuries have had these balances wiped out because of carrying delinquent members on

their rosters for several years. These Branches have paid per capita tax on these members to the Supreme Society until they were no longer able to do so with the result that only fourteen of our Branches were in good standing at the end of our fiscal year on May 31, 1933. The total amount due the Supreme Society at that date was $932.14.

Paying per capita tax on delinquent members is a mistake which our Branches can and should prevent. If the Branches will abide strictly to the constitutional requirements outlined in Article 7, Sections 2 and 3, provided for such conditions, this would not occur. Had our Branches followed these provisions they would not be indebted to the Supreme Society.

It may be true that we would be liable to lose members more quickly if they were dropped from the Branch after the specified length of time, but, certainly, they would be reinstated sooner. It is much easier to pay $6.00 back dues and be reinstated than it is to pay $18.00 for three years back dues. If the "*Monthly Review*" was taken away from members as soon as they were delinquent three months, most of them would make an effort to pay their dues.

It is my opinion that Branch societies should use discretion in the suspension of members only when the financial condition of the Branch is such that it can assume the responsibility. Then the loss would not fall on the Supreme Society.

The Supreme Society is very liberal with the Branches, assessing them only 35% of the minimum dues or $2.10 per member annually. Do you know that about 80% of all the money received from per capita tax is spent to provide the "*Monthly Review*" and only 20% is used for administrative expenses, salaries, etc.? This means that each member pays fifty cents per year for the actual running of the organization.

In answering the last question, I feel confident in the prediction that "We Stand On The Threshold Of A New Era" which will see the society grow as it never has before. Its accomplishments will be recognized everywhere. The members of the American Electro-Platers' Society will be proud of their membership in this self-made organization which is accomplishing real progress in its genuine endeavors.

FRED J. LISCOMB

Fred J. Liscomb, a Charter Member of the Chicago Branch, A. E. S., and one of the first Officers of this Branch, and an authority on plating matters, died suddenly July 29th, 1933, at the Swedish Covenant Hospital in Chicago. He was 66 years of age, born in the state of New York, and started his early career as an Electro-Plater in and around Cleveland, Ohio; afterwards going West, locating at Fort Leavenworth, Kansas; later in Grand Rapids, Mich.

"Dad Liscomb" was known to most of the platers in the American Electro-Platers' Society, and the Electro-Chemical Society, of which he was also a member. In 1906 he became associated with the Western Branch of the Hanson & Van Winkle Co., as salesman and plating engineer; and, but for a short interim with the Crown Rheostat and Supply Co. until about two years ago when he retired from the present Hanson, Munning Co. to open his own Laboratories for consultation, research and investigations of Manufacturers Electroplating problems.

During the World-War he was detailed at the Bureau of Standards of the Department of Commerce at Washington, D. C. and assisted in overcoming many of the plating problems that confronted the U. S. at that time. Eighteen years ago he published a book on Volumetric Analysis that was invaluable to the plating foreman and was one of the first reforms in creating scientific mechanical information for student electro-platers. He contributed many articles on plating to the A. E. S. Review—ever progressive and a deep thinker, his slogan "Ask Dad" ever popular with the Electroplating fraternity was typical of his generosity and willingness always to help his fellow men, and this, with many other suggestions supplied with facts and data, will always endear his memory to those whose pleasure and privilege it was to know him.

He will be missed by his many friends, because of his sterling character and kindly disposition.

SUMMARY OF WORK ON ELECTRODEPOSITION AT THE BUREAU OF STANDARDS*

By Dr. William Blum

Read at the Chicago Convention, 1933

I. GENERAL

The personnel of the section remained the same, although the time available for research was somewhat reduced by furloughs. A new room was equipped for accelerated corrosion testing at a constant high temperature and humidity.

II. PUBLICATIONS

Research Paper No. 476, "Theory of Chromium Deposition", by C. Kasper, was published in the September (1932) Bureau of Standards Journal of Research.

Research Paper No. 511, "A Metal-Connected Glass Electrode", by M. R. Thompson, was published in the December (1932) Journal of Research.

A progress report, "Protective Value of Electroplated Metal Coatings on Steel", was published in the January (1933) *Review* of the American Electroplaters' Society and was subsequently reprinted in other journals. It was also distributed in mimeographed form.

III. RESEARCH PROJECTS

1. *Protective Value of Electroplated Metal Coatings on Steel:*

(*a*) Exposure Tests—The exposure tests started in the spring of 1932, have been continued. In addition, about 24 supplemental sets for confirmation were exposed in January, 1933. These samples have been inspected at intervals of about one month in the four severe locations, and of about two months in Washington, D. C., and State College, Pa., where the corrosion is less marked. Owing to curtailment of funds available for travel, it was possible for the Bureau representative to take part in only a few of the inspections outside of Washington. Several members of the committee and other interested persons have been very helpful in making these inspections, the results of which will be presented in a separate report. Several years will elapse before these tests are completed, especially in the mild locations.

* Publication Approved by the Director of the Bureau of Standards of the U. S. Department of Commerce.

(*b*) Accelerated Tests—Ferroxyl, salt spray, and intermittent immersion tests have been made on the companion samples to those exposed, in order to determine whether such tests will serve to predict the relative behavior in atmospheric exposure. The conclusions will be presented in a report by P. W. C. Strausser, Research Associate of the American Electro-Platers' Society.

(*c*) Stripping Tests—Studies have been made by A. Brenner on methods of stripping single or composite plated coatings from steel. The results, to be reported in a separate paper, will be of value for the analytical testing of plated coatings, and for stripping prior to replating.

2. *Deposition of Chromium from Solutions of Chromic and Chromous Salts:*

In a paper by C. Kasper to be published in the near future in the Journal of Research, the literature on the deposition of chromium from its salts is critically reviewed. Further experiments showed that it is possible to produce bright chromium deposits from solutions such as chrome alum, chromic fluoborate and chromous sulphate, but that in all cases the efficiency for bright deposits is less than five per cent, and the plating range is narrower than for the chromic acid bath. With our present knowledge, the development of a bath superior to the chromic acid bath does not appear promising.

3. *Analysis of Tin Plating Baths:*

Preparatory to undertaking a study of tin deposition, M. R. Thompson has made a study of the methods of analyzing the solutions, especially the alkaline tin baths. The results will be reported in a separate paper.

4. *Behavior of Cyanide Solutions:*

Prior to an investigation of silver plating, R. M. Wick made a study of the factors which affect the decomposition of cyanide plating solutions, upon which a preliminary report was presented to your last Convention. In the completion of this program, it was predicted and subsequently confirmed that immediate decomposition products between the cyanide and carbonate might be formed in at least small amounts, and might then affect the operation of the baths. The results of this study will be reported in a separate paper.

IV. SPECIFICATIONS

Assistance was given to several committees in the preparation or revision of Federal Specifications that included plating. Such specifications are important, because they not only determine the quality of goods purchased by the Government, but also, both directly and indirectly, may affect the standards for articles made for the general public. The following requirements have not yet been promulgated, and they are included here merely in order to solicit comments and suggestions from interested parties.

(*a*) Silver Plated Tableware. Up to this time the Federal Specification has been based on "6 oz. teaspoons", corresponding to an average thickness of about 0.0008 inch of silver. As the requirements of many Government establishments are equivalent to severe hotel service, it is now proposed to increase this requirement to "9 oz. teaspoons", that is to an average thickness of 0.00125 inch. The approximate areas of typical pieces of flatware and hollowware were measured, in order to make the specified weights of silver proportional to these areas.

(*b*) Plumbing Fixtures. On brass fixtures it is proposed to retain the present specification of 0.0002 inch of nickel, followed by 0.00002 inch of chromium. There has been considerable difference of opinion regarding the chromium plating of "white metal", which is 18 per cent nickel brass (nickel silver.) This Bureau has recommended the application of 0.0001 inch of chromium directly on the white metal, in order to obtain more resistance to abrasion than can be obtained with a thinner coating of chromium. If the heavy chromium coating is applied, the nickel is unnecessary, but there is no objection to it.

(*c*) Testing. The testing of metal coatings on Federal purchases, formerly conducted by another section of this Bureau, was taken over by the plating section. This work includes galvanized iron, tin and terne plate in addition to zinc plated conduit, chromium plated plumbing fixtures and hardware, and silver plated tableware. This close contact will enable us to judge the ability of manufacturers to meet specifications such as those above mentioned.

V. MISCELLANEOUS ACTIVITIES

We have continued our active cooperation with the Bureau of Engraving and Printing, and have made analyses of solutions and tests on iron anodes. In addition, we have furnished advice or assistance on numerous problems encountered in the daily operation.

Regular analyses of plating solutions have been made for Camp Holabird in Baltimore. The results will not only lead to more regular operation of the baths, but will, we hope, furnish useful information regarding the consumption of chemicals in typical plating processes.

We have continued our cooperation with the Metallurgy Division of this Bureau in a study of the anodic oxidation of aluminum, and especially of the factors that affect the stability of the baths and the quality of the coatings.

Even with the slight decrease caused by business conditions, there have been each month an average of about eight visitors and one hundred requests for information (apart from requests for publications.)

VI. FUTURE PLANS

Owing to the general reduction of Federal appropriations, less money will be available for research in this field than in previous years. It is not yet possible to make exact plans for the coming year. In general the available funds will be employed largely for investigations of a fundamental nature, which are not likely to be undertaken by the industries. Experience has shown that the results of such studies frequently have far-reaching effects on both science and industry. At the same time an effort will be made to continue our active participation in those projects in which industry cooperates through the employment of Research Associates. (Applause)

CHAIRMAN WATTS: Are there any questions which anyone would like to ask Dr. Blum?

MR. D. GREENBLATT (Garden City Plating & Manufacturing Co.): Why should you deposit any nickel on the German silver in order to give it a chance to chrome plate direct, the same as anything else?

DR. BLUM: That question is one which has been the basis of a good deal of discussion and correspondence, and it would be difficult to go into the details here. Let us just go back a little bit and understand that chromium is put on a thing like a

plumbing fixture or hardware primarily to improve the appearance, the resistance to tarnish, and also resistance to wear. Practically, when you put a nickel plating on brass or any other metal it is difficult, I don't say impossible, to apply much more than two hundred thousandths of an inch of chromium, or, at least, your tendency for peeling will increase, if you put more than two or three hundred thousandths of an inch of chromium over a nickel deposit. If you do that, then you have a thin chromium deposit which, of course, will not resist wear as well as a thicker chromium deposit. If, however, you have no nickel coating underneath, you can apply as thick a coating of chromium as you choose without danger of peeling because there is nothing under the chromium to peel. I admit with Mr. Greenblatt, that it is more difficult to get a good bright chromium finish directly on the white metal and in many cases it will probably require some buffing. But, on the other hand, we know, not from our experience but from platers including job platers, who have simply had to take conditions as they were in their own plant, that it can be done. It may be a little more expensive. It may be a little more troublesome, but it can be done. The conditions can be met and so far as we can find out among those who are experienced in this field, it is the belief that to those fixtures made of at least eighteen per cent nickel silver, which should not etch very much, chromium can be applied directly to get a finish that is brighter all over and which will resist abrasion better than the thin coating of chromium that is put on the ordinary decorative chromium job.

To go one step farther, if the plater finds it advantageous to put on a thin coating of nickel, but to follow it up with a ten thousandth of an inch of chromium, there is no objection to that. The main thing is to put on the heavy chromium. If he can do it over nickel and can do it better than directly, there is no objection to it. The main requirement is that it shall have that heavy coating of chromium on it.

Mr. Greenblatt: In the specification which we have from the government it has to be exact. If not, it is found out and the whole job goes back.

Dr. Blum: I realize that and it is one of the things in which I sympathize with the platers for this reason: that it takes a long time to revise the specification. The Federal Specification

Board, as it is called, consists of representatives of each of the government departments, and they in turn have committees on this, that and every other material.

Suppose, now, we have this question of specification on white metal. It may come from the manufacturer, that is, the proposed change may come from the government department or from the manufacturer. At any rate, a proposal is made. It is circulated to manufacturers. Their ideas are obtained. Then perhaps the specification is modified. It is again circulated to the manufacturers. Then after the committee is agreed on it, it has to go and receive a formal approval of every one of the government departments before it can be put into effect. But, in the meantime, the government is buying material, and the consequence is that one purchasing agent for one department may follow one proposed specification and another one may follow another proposed specification. Thus I admit that it is often difficult, and we have had a great deal of sympathy with manufacturers who have found it hard to know what specification they were supposed to meet. All we can say is that this is one of the unavoidable conditions in an organization as large as the government.

Remember the Bureau of Standards is, so to speak, on the side lines. We can not tell any government department what to do. We can advise them, and that is all, and in giving that advice, of course, we are trying to systematize and standardize. And we have, I say, recommended the one ten thousandths of chromium, but stated that the nickel was not objectionable, although I believe that in most cases, at least during this period, the specification when issued has called for a ten thousandths of an inch of chromium directly on the nickel or silver. It is just such points as this that we hope you folk, even if you have no chance to discuss them, will write to us about because we want to get the benefit of the experience of the platers.

CHAIRMAN WATTS: Are there any further questions?

MR. WALTER R. MEYER (General Electric Co.): I would like to anticipate that paper on the deposition of chromium. Did you use porous diaphragms?

DR. BLUM: We worked with and without diaphragms.

MR. MEYER: What kind of coating efficiency did you get?

DR. BLUM: It varied for bright deposits. It was around five per cent. In a trivalient bath it is equal to ten per cent in a chromic acid bath, so we were in the same position as we were

with the chromic acid bath. The throwing power did not particularly investigate because the plating range was so narrow. A change of twenty per cent in the current density would make a big difference in the appearance of the deposit, so that if we used one hundred amperes per square foot to get a bright deposit if we had 80 or 120, the deposit would not be bright. There is no use measuring the throwing power under those conditions.

MR. MEYER: Did you cover pH ranges in those baths?

DR. BLUM: Yes. The difficulty is that you can increase the efficiency by raising the pH. That is, having the solution more nearly neutral, but you decrease the plating range because you are more likely to get dull or burnt deposits.

MODERN METHODS OF ETCHING AND COLORING

By G. H. Mamerow

Read at the Chicago Convention, 1933

We are today reviewing a Century of Progress in all branches of Science and Industry.

The etching industry on a commercial basis is still in its infancy, although much progress has been made in the last ten or fifteen years.

The basic principles are still followed but with the aid of electroplating and the application of colors we are now producing by combinations finishes that are not only beautiful from an artistic viewpoint, but are practical as well.

Although the process of etching of metals has been previously brought to our attention in THE MONTHLY REVIEW it is surprising to know how few are familiar with the methods of manufacture.

Briefly then, let us outline in one general way the essential steps necessary in the production of articles made by this method:

The raw material in sheets cut to process size is first prepared with that finish which later will be the highlights of the etched plate. For example, a plate having buffed nickel letters makes it necessary to buff and nickel plate the metal in sheets as the first step; Chrome letters or highlights, silver plated, black oxidizing or any plated finish (with few exceptions) must all be done before printing or etching. Here we find one of the outstanding peculiarities of the etching industry in that the finish of the article is applied before fabrication. This, of course, requires

utmost care in the handling of the work as it progresses through the various steps before we have a completed article. We are, therefore, confronted with difficulties that are not usually found in other lines where the buffing, plating or oxidizing is applied to the finished article.

We shall assume, then, that our stock is now absolutely grease free and without tarnish, ready for printing.

The design or lettering is lithographed to the carefully prepared surface of the metal sheets and is followed by dusting a suitable resist powder over the entire plate. The background is wiped free from resist powder which clings only to the wet ink. Baking to the correct temperature on a conveyor belt melts this powder to a solid film not affected by acid or plating solutions. Thus, we protect the original finish of the metal which you see will be the "highlights". The backs of the sheets are now protected and this is followed by the process of etching. This is done by submerging racks of sheets in an air-agitated solution. Different metals require different etching acids, Chloride of iron for brass and bronze—Hydrofluric and Muriatic for aluminum—Nitric acid for steel—Sodium Bichromate and Sulphuric Acid for zinc, etc.

When the etching is completed the background is ready for oxidizing, silver plating, copper, nickel, Chrome or colored enamels or combinations of the various finishes that produce pleasing contrasts with the highlights. Remember, that the resist is still on the sheets and this the plater has to contend with if the requirements call for a plated background. A good example is a clock dial of beautiful white frosted background and black raised numerals. Another is the panel having Chrome highlights and oxidized silver background.

A black background on brass is produced by oxidizing the exposed surfaces in an ammonia copper carbonate solution; black on aluminum is black nickel plated directly to the metal; zinc is blackened in a sodium sulpho cyanate solution. If a color is required it usually is applied before removing the resist and must be of such material that is insoluble in naptha or benzine and in a great many cases today, must stand plating solutions. When the correct finish has been applied to the background, the resist is removed and the sheets are then cleaned and lacquered. The lacquer in most cases must be of a special nature.

Let us stress the fact that we now have a sheet of metal prepared with the finish as required by the customer, ready for various machine operations. After shearing to strips the plates are blanked out, formed, perforated or numbered. If the finish stands all of this handling one can feel assured that the article is most likely to serve the customer well. Today, however, most finishes must withstand weather conditions, violet ray tests, salt spray and abrasion tests.

One can readily see that the plater in this industry must be a specialist, for he has work to do that requires a technique different from the usual methods of plating—he has resist, colored enamels, inks and lacquers to contend with. There are few platers who are required to nickel or Chrome plate a piece of brass or steel without first passing it through the electric cleaner. Yet, this must be done—and is daily accomplished—to meet rigid salt spray and adhesion tests.

We have here some interesting samples from the plater's viewpoint: The instrument panel marked No. 1 is finished in Butler Chromium highlights and oxidized silver background. The Chrome plating is done in the sheet before the resist is applied. The exposed background is stripped of Chrome and etched, satinned and silver plated. Resist is then removed and the sheets are put through dies for blanking and perforating. Lugs are soldered on the back, which is followed by oxidizing the silver final rubbing down and lacquering. This panel stands up satisfactorily under salt spray and abrasive tests. Careful handling is absolutely necessary, for the slightest scratch scraps the entire plate and it cannot be refinished, for the resist has been removed.

The brown panel marked No. 2 with Chrome highlights is processed in much the same way except that the bronze background is oxidized and rubbed down to an antique finish. The oxidizing agent does not affect the Chrome.

One casually looks at this instrument panel marked No. 3 and remarks, "Oh, yes, just nickel plated and black enamel". Not so easy! Some very interesting problems were encountered. For instance, an enamel was made that would be flexible enough to stand forming, be hard enough to be capable of receiving a high buff and it also must stand 450 degrees of heat when soldering lugs and finally have adhesion to the metal when the final nickel and Chrome plate is applied.

To produce the wood grained effect in panel No. 4 would be simple enough if the requirements weren't about as stringent as in panel No. 3.

A very pleasing combination of finishes is represented in sample No. 5 which is stainless steel of the 18-8 variety. Here, you can see part of the highlights are in polished bronze and part in the polished stainless steel. The frosted background is produced by etching.

The black sample, No. 6, is also 18-8 stainless steel and we have here, polished highlights in steel and black as well as satin background carried out in black and white. Here, we have an example of a "rustproof and non-corroding" material having been etched and plated to produce a quite pleasing effect that is really serviceable as well as ornamental.

Another small panel marked No. 7 demonstrates the possibilities of artistic decoration in stainless steel with colors.

Sample No. 8 shows a walnut grained effect by the use of chemicals and is not an application of ink or enamels.

Time does not permit going into further detail and it is the wish that some facts have been brought to your attention that may be of some benefit if not at least interesting in this comparatively new line of endeavor.

I would be glad to answer any questions anybody would like to bring up in the way of formulas or solutions or processes and finishes. Incidentally, I didn't mention this before, but here we have what we think is a pretty nice piece of work. That is processed on bronze. It is etched and enameled and later on the lugs are soldered on and the Chrome plating is applied, the whole thing, of course, being buffed and polished to a mirror finish.

We etch aluminum in several solutions. The real solution is a mixture of ferric chloride and muriatic acid and water. The muriatic acid alone would be too violent an etch. There would be too much hydrogen gas coming off the sheets and would produce too much heat, so we have to cut down this chemical action. We find that by putting in ferric chloride we replace the aluminum that is etched away with the copper deposit at the same time, and therefore retard this chemical action.

MR. GARTLAND: I should like to ask the speaker the formula he used in blackening zinc.

MR. MAMEROW: Sodium sulphocyanide with zinc sulphate. I haven't these all in mind. It is nothing more than a black

nickel solution. Keep the amperage very low. It plates very readily and doesn't take very long to produce a good black. It is nothing more than a regular eight-ounce black nickel solution. We can oxidize zinc with or without current. In a great many cases we use only a very, very slight amount of current, not more than one or two volts.

MR. E. J. MUSICK: Are you the author of the paper and the man who did the plating? Is it your work out here, some of your personal work?

MR. MAMEROW: Yes. We have an exhibit out here of some of our work.

MR. MUSICK: I would suggest you post out there or attach some place the formula used. If you put the explanation of your process there you will be entitled to the only award that is to be given, but until you qualify your exhibit by having a formula posted, we can't consider it. We should like very much to make an award, and if you will post any time during the day or tomorrow morning the formula of the different solutions used, we can consider the collection here. The paper described it.

MR. MAMEROW: I shall be glad to.

MR W. H. PHILLIPS: I should like to ask one rather general question. What type of material is this resist, asphaltum material or artificial rosin, or what?

MR. MAMEROW: The type of resist is a mixture of asphaltum, rosin and beeswax, a preponderance of asphaltum, that is, lump Egyptian asphaltum. There are ten pounds of asphaltum, two pounds of beeswax and about one pound and one-quarter of rosin cooked together and poured out in a pan to dry and later pulverized in a mill to a very, very fine flour. This flour adheres to the wet ink on the highlights of the lithographed design. As I said before, it is dusted off carefully from the background because wherever that powder remains that portion will not be etched, when it is baked. It requires about three hundred degrees in most cases to bake this rosin powder.

MR: PHILLIPS: For what time?

MR: MAMEROW: Just bring it up to 300 degrees of heat and it will flux together and form an impervious coating. It is a peculiar thing that the slightest touch of benzine or turpentine will remove this resist powder. Of course, burnt to a higher degree of heat makes it harder to dissolve later on. It burns out the oils and the wax.

MR. PHILLIPS: There is no reflow to that when you heat it up?

MR. MAMEROW: No. It is confined to the limits of the lithographed design itself and that is an advantage, in that we can produce very, very small minute lines. If any of you gentlemen are interested in this line of work we should be glad to take you up to the plant and show you just how it is all done. Does that answer your question?

MR. PHILLIPS: What asphaltum do you use?

MR. MAMEROW: It is Egyptian lump asphaltum and it is bought that way right here in town.

MR. ALBERT CAMERON (Taylor Institute Corp.): I would like to ask the speaker regarding the recovering of the iron chloride solution. Is that a practical method?

MR. MAMEROW: Yes, it is. I will speak about that. When we etch brass or bronze or nickel silver in chloride of iron, we use ferric chloride. In the etching process the copper and the zinc of the metal go into solution, of course, and also change ferric chloride to ferrous chloride. In this etching solution we have an amount of free muriatic acid to minimize the scum that is formed on the metal. This muriatic acid stays as free muriatic acid. When the solution becomes so weak and so filled up with copper chloride and zinc chloride, it ceases to function. We clarify that by throwing it into a tank filled with scrap iron. The free muriatic acid present aids the clarifying of the ferrous chloride by the plating out of the copper on to this iron scrap by an immersion process. The muriatic acid also eats up the iron and forms ferrous chloride. The copper, plated out, precipitates down to the bottom of the tank and you draw off your solution of ferrous chloride, put it into the etching tank, add your free muriatic acid and then add chlorate of potash which changes the ferrous chloride back to ferric chloride and you start all over again.

It is very interesting to see that copper tree formation on the iron scrap. You buy your metal and etch it and sell your recovered copper for scrap later on.

MR. KOCOUR: On plate No. 1, that delicate green, what about that?

MR. MAMEROW: That was an instrument panel. I only have the small one here. Anyone can see that on the Packard automobile today. It is produced by chrome plating the sheets first.

The stock as it comes from the mill has no finish. We Butler finish on the plain brass, then nickel and chrome plate it, bright, of course, print our design, etch the background away, leave the resist on and then satin it. That satin is done in a bichromate solution. Then give it a good coat of nickel and a good heavy coat of silver, wash off the resist, solder the lugs on the back before the panels are oxidized because the heating of soldering will burn up the silver sulphide finish that is put on, then immerse it in potassium sulphide and finally rub it down to the French gray finish.

MR. KOCOUR: How is that slight green made?

MR. MAMEROW: That slight green cast is attained in removing it from the sulphide solution just before it turns an intense black. As you know, when you oxidize silver in a sulphide solution you have various stages of color, and the trick of the thing is to pull a piece out just at the right time.

MR. KOCOUR: That is the point I wanted you to bring out.

MR. MAMEROW: In the antique bronze finish that isn't necessary because that can be oxidized to a clear black and then later rubbed down with a brush and pumice stone.

MR. F. P. ROMANOFF: What is the length of time required for etching the various materials?

MR. MAMEROW: It depends on the finish. Brass and bronze for the ordinary name plate are etched in from fifteen to twenty minutes. The depth of etching required in enamel fill jobs takes much longer. I would say about twenty-five to thirty minutes. The action is slow on brass because too violent an action in etching will remove the resist. That is one thing we have to contend with. The commercial name plate is etched about one to .001 and .0015 deep. Where we apply color it is from .003 to .004 deep. For lithographing the color in the background, the metal is usually .002 deep, varying with the strength of the acid from fifteen to twenty or twenty-five minutes. Etching aluminum produces a much more violent chemical action. We will etch about .0015 to .002 in less than five minutes. Zinc is about the same as brass. Does that answer your question?

MR. CAMERON: In coloring the highlights in the finish is there any danger of buffing out the lacquer already in there, causing it to break away from the base metal?

MR. MAMEROW: Yes, we have found that there is, depending, of course, upon the nature of the work. You take a piece like that

enameled panel back there, we find it necessary to apply two to three coats of buffing lacquer before we can color up the highlights. Then, also, we have to limit our buffing to a very slight buffing for the reason the edges of an etching are very sharp and, of course, the buffing wheel will cut the plated finish right off the edge. In stamping or embossing, we don't have those real sharp edges that are produced in the etching; they are made more rounded making it easier to buff without cutting through.

PLATING STAINLESS STEEL

By Joseph Hoefer
Chicago Branch

The problem of plating stainless steel is very closely connected with the problem of passivity. Most present day investigators consider passivity to be due to the formation of a protective oxide film. Regardless of its actual constitution, it is not new to the electroplater. Nickel anodes for a number of years have had the bad habit of becoming passive and not going into the solution where there was an absence of chloride ions. Aluminum is passive when exposed to the atmosphere and to most solutions not containing the chloride ion. We are all familiar with the various chloride dips so necessary to secure an adherent plate on aluminum. As far as appearances to the unaided eye are concerned, a metal that is passive is no different than a piece of the same metal that is not passive. This condition is very much like the condition so aptly expressed by David Harum in regard to some people. "Thar isn't much difference between the best of 'em and the worst of 'em but what ther is, is mighty important."

And the difference between passivity and non-passivity is mighty important. No metal with the possible exception of chromium can be electrodeposited on stainless steel without removing this bugaboo, passivity. And even in the case of chromium usually a plate having grey spots is produced. In some instances, however, where the current is applied slowly, there is sufficient cathodic reducing action to simultaneously remove the passive film and produce a uniform chromium plate. However, if a heavy wearing coat of chromium is to be produced and no hydrochloric acid dip is used, it will invariably scale, indicating that here, too, it is advisable to remove the passive film with the chloride ion.

Some months ago when this problem of plating stainless steel first confronted me, the first method of attack to suggest itself was, naturally, the removal of the passive film by hydrochloric acid immersion. A number of stainless steel strips, such as you see here, were secured and plated under various conditions. These strips are of the 18 and 8 composition having 18% chromium, 8% nickel, and 0.2% carbon. This stock came to us in the semi-polished mill finish. It was cut into strips and then buffed on one side without removing the coarse wheel marks which are so evident in the mill finish. We felt certain that if perfect adherence was secured on the buffed surface, there would be no difficulty with the unpolished surface.

TABLE 1.
TREATMENT WITH 6 NORMAL HYDROCHLORIC ACID*

Sample No.	*Time of Immersion*	*Temperature*	*Subsequent Treatment*	*Plating Bath*	*Character of Deposit*
1	Momentarily	70° F.	Rinsed in Cold Water	Cyanide Copper	Very uneven non-adherent
2	30 sec.	70° F.	Rinsed in Cold Water	Cyanide Copper	non-adherent
3	1 min.	70° F.	Rinsed in Cold Water	Cyanide Copper	non-adherent
4	2 min.	70° F.	Rinsed in Cold Water	Cyanide Copper	fair adherence
5	1 min.	70° F.	Rinsed in Cold Water	Acid Copper	slight adherence
6	1 min.	70° F.	No rinse	Acid Copper	spotty adherence
7	1 min.	70° F.	No rinse	Copper Chloride	spotty adherence
8	1 min.	70° F.	No rinse	Copper Chloride	spotty adherence
9	1 min.	100° F.		Copper Sulphate	spotty adherence
10	1 min.	130° F.		Copper Sulphate	withstood buffing

Some samples were treated with 12N hydrochloric at 130° F. and produced perfect adherence but objectionable pits were present. Treatment with hydrochloric acid alone proved rather uncertain. At times, perfect samples would be produced. Then again they would be non-adherent.

After conducting these preliminary experiments, it became somewhat apparent that our difficulties could be separated into several distinct phases. First, one minute may not have been sufficient time for the hydrochloric acid to activate the surface. Rinsing and slight exposure to the atmosphere may have caused certain areas to again become passive. Plating in a copper sul-

* To make up 10 gallons of 6 Normal Hydrochloric Acid 5.4 gallons of 22° BE or 5.6 gallons of 18° BE Concentrated Hydrochloric Acid is required.

phate solution would also tend to produce passivity. This fact was particularly noticeable when the current was not applied immediately. When this condition existed, the lower part of the piece would plate but it was impossible to get a deposit in the center of the sheet, particularly if it was a large one.

Something had to be done to activate the piece entirely and at the same time prevent subsequent passivity. With this in mind, an arsenic hydrochloric acid dip was tried.

TABLE 2.

TREATMENT WITH ARSENIC HYDROCHLORIC ACID DIP CONCENTRATION OF ACID 12 NORMAL

Sample No.	*Concentration of White Arsenic*	*Ferric Chloride*	*Plating Bath*	*Character of Deposit*
11	2 ozs./gal.	none	Acid Copper	Spotty adherent plate
12	4 ozs./gal.	none	Acid Copper	Spotty adherent plate
13	6 ozs./gal.	none	Acid Copper	Adherent withstood buffing
14	8 ozs./gal.	2 ozs.	Acid Copper Cyanide	Adherent withstood buffing
15	8 ozs./gal.	2 ozs.	Bronze Cyanide	Adherent withstood buffing
16	8 ozs./gal.	2 ozs.	Gold Nickel	Adherent withstood brushing
17	8 ozs./gal.	2 ozs.	Sulphate Nickel	Adherent withstood buffing
18	none	none	Chloride	Adherent withstood buffing

For most commercial work in the deposition of gold, copper, brass, or bronze on stainless steel, the arsenic hydrochloric acid dip should be used. However, if arsenic is objectionable, or still better adherence is desired, it is advisable to use a nickel chloride dip and nickel plate in the manner described in the subsequent paragraph. Treated in this manner, the piece can be bent repeatedly without cracking or peeling. This cannot be done when the arsenic dip is used; the plate will invariably crack and peel. This does not rule out the arsenic method, however, as a large part of our present day nickel, particularly on brass, will do the same thing if given a similar treatment.

You will note on plate No. 18 no arsenic dip was used and yet in the nickel chloride bath, an adherent plate was produced. Of course, a momentary dip in Muriatic acid was given. This chloride bath had the following composition:

Nickel Chloride	10 ozs. per gallon
Sal Ammoniac	2 " " "
Boric Acid	3 " " "
PH	5.8

The result secured with this bath proved quite interesting, particularly in view of the fact that a copper chloride bath failed

to produce uniform adherence. This would be expected, however, when we consider that the free hydrochloric acid activated the surface and a copper immersion deposit was produced before actual plating. With nickel immersion deposition does not take place.

Most plating rooms do not have a nickel chloride bath. Besides, the quality of the nickel is not as good as the sulphate bath. The question immediately arose. Why not make up a nickel chloride dip and use the regular nickel sulphate-chloride plating solution? For this experiment, a nickel bath of the following composition was used:

28 ozs. per gallon.....Nickel Sulphate (Single Nickel Salts)
7 " " " .....Nickel Chloride
3 " " " .....Boric Acid

This solution was operated with the following conditions existing:

PH.....2.5
Temperature.....120° F.
Current Density.....35 amperes per square foot

The nickel chloride dip was made up of 16 ozs. per gallon of nickel chloride in 6 normal hydrochloric acid. From this experiment, very gratifying results were produced. The pieces were cleaned in the ordinary manner using the following sequence: "Electrocleaner", rinse, acid nickel dip 30 seconds, rinse and plate for 8 minutes. The sample you see plated in this manner was bent repeatedly in every direction. The adherence is perfect.

Undoubtedly, you are beginning to wonder why we should study the plating possibilities of stainless steel? That is a fair question and here is the answer. Within the next four years, the protection period of the basic patents on stainless steel will have expired; in fact, one of the Krupp patents will be without protection in three years. One of the local steel mill executives told me just recently that he expected stainless steel to drop to less than half its present price. From this, you can see that stainless steel is just around the corner. Let us hope it is not nearer than prosperity, however.

For beauty combined with durability in architectural applications stainless steel cannot be surpassed. The judicious distribution of contrast and color on stainless produces some amazingly beautiful effects. Plating with copper, brass, bronze, or gold lends itself admirably to this class of work. Here are a few bronze plated name plates which give a feeble illustration

of the possibilities. I have also gold plated some stainless steel pens. This form of plating on stainless has vast possibilities in the jewelry field.

But by far the largest field for plating stainless steel lies in the present field occupied by chromium. This field is occupied by chromium and I feel that it will continue to be occupied by chromium. The first fact that comes to our attention in investigating this matter is that while practically all research bulletins on atmospheric corrosion of stainless steel state that the 18 and 8 variety will resist atmospheric corrosion indefinitely, they go farther and state that the higher the chromium content the more resistant the steel becomes. This being true, why not give the surface a film of pure chromium? What more resistant metal do we have? A stainless surface possesses microscopic pits. Why not cover these remote sources of corrosion with a ductile and perfectly adherent coat of nickel? Nickel is easier to buff than stainless steel and is capable of taking a higher luster. To obtain a lustrous nontarnishing finish, the nickel chromium combination cannot be beaten.

NOTICE

The proceedings of the Chicago Convention are now printed and ready for mailing.

Any Member or Branch will receive a copy of the same by writing to Mr. H. A. Gilbertson, Secretary-Treasurer, A. E. S., 434 S. Wabash Ave., Chicago, and enclosing check for $3.00 plus mailing cost.

NOTES ON STRAY CURRENTS IN PLATING BATHS

By Gustaf Soderberg

Read at the Chicago Convention, 1933

When we think about plating we generally picture all the current as passing out of the anodes and through the solution to the work, where it deposits metal and in most cases also hydrogen. This is, of course, the ideal condition. It is realized, however, only in the laboratory when we work with glass beakers or battery jars, and in the plating shop only sometimes when rubber lined or pitch lined tanks are used.

When tanks are made of plain steel, when they are lead lined, and when heating and cooling coils are used, we frequently encounter complications. As a general rule these complications

are of such a small magnitude that we do not notice them. Occasionally they cause more serious trouble, such as heavy rough deposits on the tank walls, current losses and abnormally long plating time. Thus both economic losses and loss of control are involved.

The purpose of this paper is to relate some experiences we have had with plain steel tanks for cadmium plating, to explain the cause of the phenomena and to show how bad conditions can be remedied.

Let us first take the case of a tank which is perfectly insulated from the floor and from all other equipment in the shop. The only way the current can enter and leave the tank is through the regular busbars. Let us also suppose that anode and cathode rods are perfectly insulated from the tank. I have seen several cases when such a tank was plated on the inside. It was evident that stray currents had their play in the solution.

The explanation is very simple if we consider that all the current does not follow the path of the least resistance.

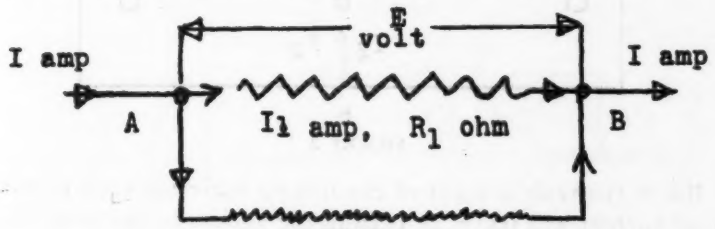

FIGURE I.

I_2 amp., R_2 ohm

If we apply a potential difference of E volts at points A and B in Fig. 1, which constitute the ends of a resistance of R_1 ohms, a current

$$I_1 = \frac{E}{R_1} \quad (1)$$

will flow through the resistance. If we also connect a much higher resistance of R_2 ohms, a small current

$$I_2 = \frac{E}{R_2} \quad (2)$$

will flow through the high resistance. The total current which flows between A and B is now

$$I = I_1 + I_2 \quad (3)$$

Let us apply this to a plating tank (Fig. 2). The main portion of the current I_1 travels the shortest path:

$$I_1 = \frac{E - P_A - P_C}{R_1} \quad (4)$$

when P_A and P_C are anode and cathode polarization respectively, opposing the tank voltage E.

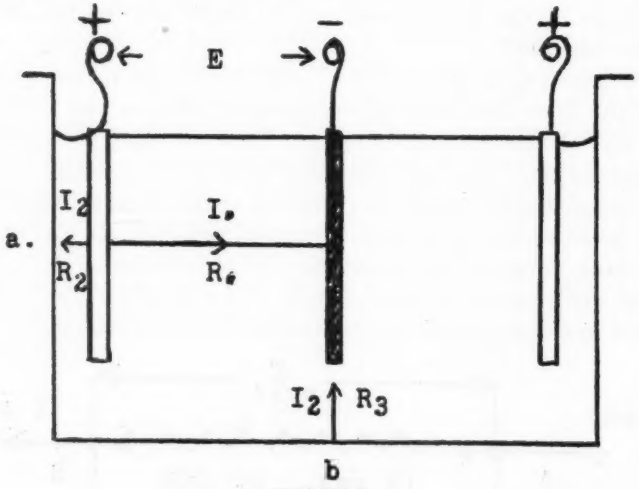

FIGURE 2.

But if the tank is made of conducting material, such as steel, some current will travel as I_2 from the anodes to the tank, then follow the tank to a point where it most easily can reach the work.

$$I_2 = \frac{E - P_A - P_{CT} - P_{AT} - P_C}{R_2 + R_3} \quad (5)$$

where P_{CT} and P_{AT} are the cathode and anode polarizations of the tank.

The total current is

$$I - = I_1 + I_2 \ (6).$$

Whatever we do, there will always be a current I_2. If it amounts to anything, we will have plating on the tank at "a". Our problem is to keep it so low that no plate is formed on the tank or at least so low that what is formed in daytime when the tank is used, dissolves during night when it is idle.

The most evident method is to put a shield of insulating material such as bakelite, rubber or glass in the path of the stray

currents. I have seen this used on barrels. The shield may be placed either where the current is liable to enter the tank as in Fig. 3 or where it leaves the tank as in Fig. 4.

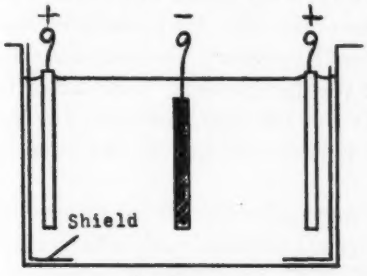

FIGURE 3.

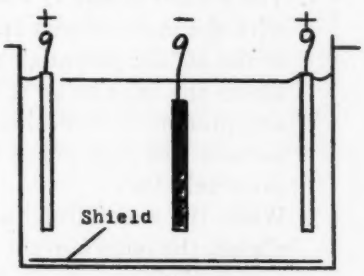

FIGURE 4.

The ends of the tanks should not be forgotten, although they are not shown in the figures.

Another method is to short circuit the tank to the anode bar. This will be discussed later.

However, most tanks are not protected in this manner. In order to determine the magnitude of the stray current I_2, we made a series of experiments, in which we used a rubber lined

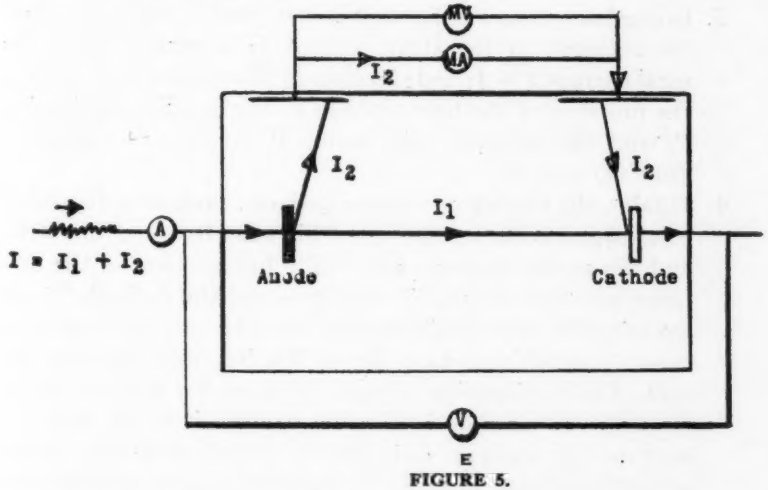

FIGURE 5.

tank and steel sheets on the side of the tank to simulate a steel tank. A top view of the set-up is shown in Figure 5. This arrangement made it possible to read the magnitude of I_2 directly. By raising the cathodic tank area out of the solution one could

see when and where plate appeared. The following facts were noticed:

1. The stray current I_2 was always very small in comparison with the main current I_1. The reason for this is the presence of the anodic potential of steel P_{AT} where the stray current leaves the tank to go to the regular cathode. This factor is not present in equation (4) for the main current I_1. No current will pass unless the current density on the steel is extremely low.
2. When the anodic steel area was cadmium plated or copper plated, the stray current increased tremendously and caused strong plating on the cathodic tank area. This is so because the anodic polarization of cadmium or copper is very small in comparison with that of steel. The practical conclusion is that anode scrap and copper or brass hooks in the bottom of the tank will always cause plating out of an equivalent amount of cadmium on the sides of the tank. A certain method of preventing anode scrap in a cadmium bath is to use the ball type anode. The rapidity with which some solutions become contaminated is also explained.
3. Going back to an anodic tank area of steel, it was found that the strength of the stray current I_2 increased when the total current $I = I_1 + I_2$ increased. The reason is, of course, the presence of the bath voltage E, the anodic polarization P_A and the cathodic polarization P_C in both of the equations (4) and (5).
4. Finally, the plating out on the cathodic tank area depended to a large extent on the exact distance between this area and the anode, and was practically independent of the distance between the anodic tank area and the cathode. From equation (5) one would expect that the *sum* of these distances was all important ($R_2 + R_3$) but such was not the case. The explanation is this: It does not matter much whether the cathode is close to the tank or far from it, because the current will always spread over the whole anodic tank area in order to keep the anode polarization down. The cathodic polarization is always comparatively small and has little effect on the total current. But if the current density on the cathodic tank area is too small, no plate is formed at all. Thus, in order to plate on the tank, the little current there is, must be concentrated on a small

tank area. This can be done only by keeping the distance between the anode and the tank very small. Three practical conclusions can be drawn from these tests. First, when a perfectly insulated tank plates, the plating can be stopped by moving the anodes further away from the tank sides and by shortening them if they reach close to the bottom of the tank. The practice of some "experts" to save solution volume by making the tanks narrow and putting the anode rods only a fraction of an inch from the tank sides is condemned. Second, the higher the throwing power of the solution, or perhaps better, the higher the covering power as determined by the minimum current density which will give plate, the greater is the tendency for plating of the tank, and the longer should be the distance between the anodes and the tank. Third, once the plating has started, the distance between the anode and the tank will diminish steadily, thus increasing the magnitude of the stray current and the rate of plating.

The next type of current leak may take place in a tank which is perfectly insulated from outside influences, if the tank rods are not properly insulated from the tank.

Wet insulation, whether porcelain, micarta or wood, will carry current, particularly when the insulating material is old and soaked with solution or when it is covered with wet salt crusts.

Treeing from the stationary, submerged cathode connection in an old type barrel may short circuit this connection to the tank.

I once saw a full automatic machine on which the tank had been connected to the super-structure by means of iron straps, holding doors which were closed to improve the ventilation. The cathode hangers touched the super-structure and the whole tank was charged cathodically.

It may be stated at once that a direct short circuit or any current leak from the work rod will cause the whole tank to plate. This condition is easily remedied.

A very slight anodic leak to the tank may not be sufficient to prevent plating on the tank when the anodes are very close to it. A stronger leak or direct short circuit will make the whole tank anodic. Because of the high anodic polarization of steel, only a small amount of current is diverted from the anodes, unless, of course, soluble scrap is present on the bottom of the tank.

The third and last source of stray currents in the bath is caused by outside leaks. Wet floors and poor insulation between the tank and the floor provide one path for the current. Other paths may be provided by a second tank touching the plating tank, by cooling or heating coils without couplings or by a suction system. Such leaks were not unusual during the last few years when little money was spent on upkeep of the plant or on the changes in layout which were made.

The first possibility is that the leakage of the current makes the tank cathode and the other branch of the leak current goes to the anode (Fig. 6.) Under this condition the tank will always be plated on the inside by "i_2". There will also be a stray current

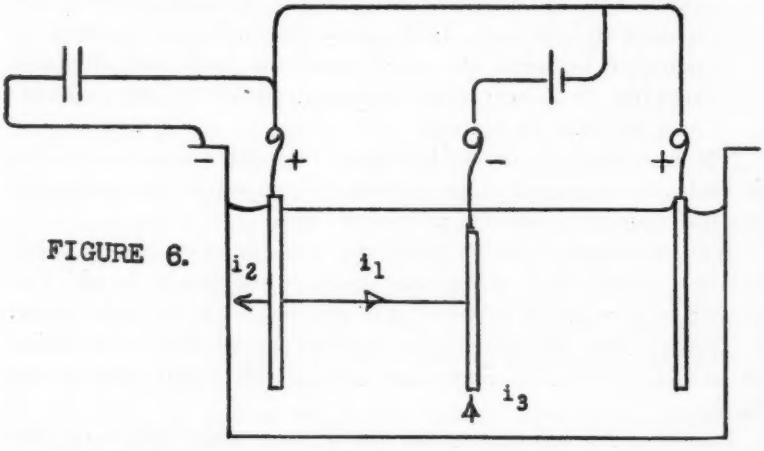

FIGURE 6.

(i_3) flowing between the tank and the work, but this current is of low magnitude. As long as the voltage between the anode and the tank "E_1" is less than that between the anode and the work "E_2", some current (i_3) flows from the tank to the work. If these two voltages become equal, this stray current disappears. If E_2 ever became greater than E_1, "i_3" would again appear, but this time it would go from the work to the tank.

This reasoning is correct when the distance between the anodes and the tank is as large as that between the anodes and the work. In all practical cases it is considerably less, and therefore the stray current (i_3) becomes zero even when E_2 is less than E_1. This difference in distances also favors deposition on the tank.

The second possibility is that the leakage of the current makes

the tank anode and that the other branch of the leak current goes to the cathode (Fig. 7.) The main current between the anode

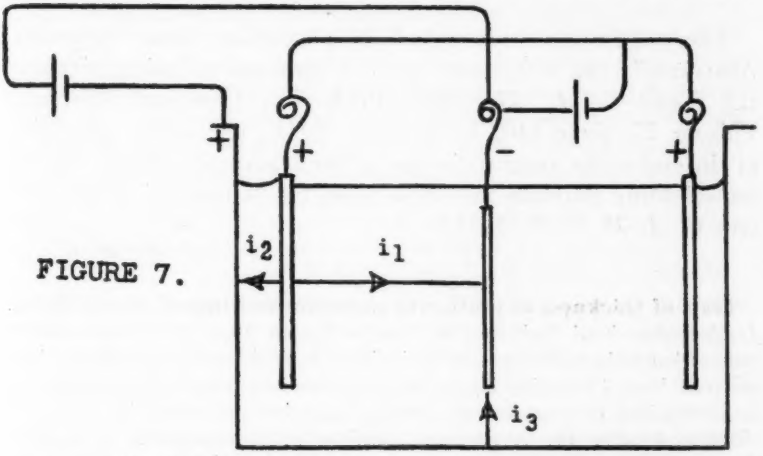

FIGURE 7.

and work "i_1" is hardly affected at all. A very weak stray current "i_2" may flow from the anode to the tank, but it does not cause the tank to plate. A larger current "i_3" flows from the tank to the work and helps the main current to plate, but because of the high potential necessary to provide any appreciable anode current density on steel, this stray current is also very small.

The remedy for these outside leaks is very simple, because the cause is easily found, if one just looks for it.

In closing, let me first state emphatically, that this paper in no way shall be taken as a condemnation of lead-lined or plain steel tanks, but rather to show what precaution should be taken with them. I will finally lay down a procedure for the prevention of stray currents which cause plating on the inside of the tank.

1. Insulate the tank from outside influences by arranging to have a clean floor, good insulation between tank and floor, insulating couplings in all pipe lines entering the tank, insulation between suction systems and the tank, and by having some distance between the tanks.
2. Insulate the tank rods from the tank.
3. Remove scrap from the bottom of the tank.
4. Move the anodes away from the tank sides and use shorter anodes, or
5. Put insulating shields between the anodes and the tank, or on the bottom and the ends of the tank, or
6. Connect the tank to the anode rods.

ABSTRACT SECTION

EDWARD B. SANIGAR

These abstracts are adapted, by permission, from "Chemical Abstracts", the references to that publication being given in the form—*C. A.*, **27**, 3402 (1933) *i.e.*, Chemical Abstracts Volume 27, page 3402 in the year 1933. The name appearing at the end of the abstract is that of the abstractor. Abbreviations for scientific journals are those used by "Chemical Abstracts" (see *C. A.* **25**, 6019 (1931.)

E. B. S.

Tests of thickness of protective cadmium coatings. S. G. CLARKE. *J. Electrodepositors' Tech. Soc.*, **8**, Preprint No. 11, 10pp (1933)—(1) A 10% soln. of iodine in a 20% potassium iodide soln. is dropped regularly (1 drop per sec.) from a dropping funnel onto the cadmium surface. The number of drops required to penetrate the coating (exposing the underlying steel) divided by 18 gives the thickness of cadmium in ten-thousandths of an inch. The method is applicable to all but pieces less than ½ x ½ inch and curved surfaces with a radius of curvature less than $\frac{1}{16}$ inch, and is accurate to $\pm$ 15%. Changes in temp., oxide films on the cadmium, or bridging of the iodine soln. over an uncoated steel area do not affect the results. (2) By means of a soln. of 20 g. antimony trioxide (Sb_2O_3) in 1 liter of cold HCl (density 1.146) the thickness of cadmium can be determined (a) by loss in weight, (b) by reduction of the dimensions, or (c) by the time of gassing in the soln. The accuracy of (a) depends on the accuracy of the determination of weight and area, the method being well adapted to small parts of which the area can be computed with sufficient accuracy: (b) is limited, because of the thinness (0.0001 inch) of the usual cadmium deposit, to small articles of regular shape: (c) while rapid in action, may give results as much as 50% in error. (3) A new reagent for the stripping of cadmium is a freshly prepared 5% soln. of ammonium persulfate in water to which is added 10% by volume of concentrated ammonia (NH_4OH) of density 0.880. The thickness of cadmium is determined by loss in weight. The accuracy is as in (2) above.

C. A., **27**, 3402 (1933.) EDWARD B. SANIGAR

Detection and significance of porosity in electrodeposited cadmium coatings. S. G. CLARKE. *J. Electrodepositors' Tech. Soc.*, **8**, Preprint No. 12, 20pp (1933.)—This paper is an account of work on cadmium-coated steel to determine the extent to which the deposits contained pinholes, the importance of porosity as a determining factor in the protective life of coatings, and the value of a porosity test for inspection purposes. To test porosity of cadmium deposits immerse the thoroughly degreased specimen for not more than 10 minutes in 1% HCl (distilled H_2O + 1% by volume of HCl of density 1.18) and note the formation of gas bubbles at the pores. The number of bubbles formed in air-free, hydrogen-saturated acid was approx. the same

as in ordinary acid, but the rate of soln. of cadmium fell from 0.006 (in the ordinary acid) to 0.0015 g./hr./10 sq. in. in the air-free acid. With bright, annealed, mild sheet steel as basis metal, change in c.d. from 3.5 to 30 amp./sq. ft., change in cleaning process prior to plating, or plating on dried instead of freshly etched and washed steel, had no effect on the porosity of the cadmium deposit. Cadmium coatings deposited from cyanide solns. of the usual composition on rolled steel of good commercial quality are ordinarily substantially non-porous. On a base of machined, cast steel, porous deposits of 0.0003 inch were given under conditions which gave non-porous deposits on rolled sheet steel. Slight porosity in a cadmium deposit is unlikely to affect its protective properties under ordinary conditions of use to an appreciable extent, but where pores are very numerous, a lower degree of protection than that afforded by a sound deposit of similar thickness may be expected.

C. A. **27**, 3402 (1933.) EDWARD B. SANIGAR

Electrodeposition of Palladium. R. H. ATKINSON and A. R. RAPER. *J. Electrodepositors' Tech. Soc.*, **8**, Preprint No. 10, 20pp (1933.)—Of 3 processes for palladium (Pd) deposition, viz., the patented complex ammine nitrite process/see Keitel and Zschienger, *Trans. Electrochem. Soc.*. **59**, 273 (1931)/, the soluble-anode process, and the Pd-ammine diaphragm process, the latter 2 are dealt with in detail. (1) *Soluble-anode process.*—A typical soln. for this process is 10g/l. Pd as $Na_2[Pd(NO_2)_4]$ + 30g/l. NaCl. When prepared, the soln. pH = 4.9, which gradually changes to a steady value of 8.0 on working without affecting the deposit. The soln. is used at 40-50° C at 0.9 amp./sq. ft., 1.5v. being required for an electrode spacing of 15 cm. Anodes are 99.9% hard-rolled Pd. Electrode efficiencies are approx. 100%. All precious metals, and many base metals and alloys, can be directly plated in this soln.; iron and steel are first plated with Ag or Cu. This process is used only for deposits up to 0.0001 inch; thinner deposits are very bright, thicker deposits often contain fine cracks. (2) *Pd-ammine diaphragm process.*—A 3-compartment rubber-lined cell is used, the catholyte (containing 20g/l. Pd, made from 40g. $Pd(NH_3)_2Cl_2$ dissolved in 35cc. ammonia (NH_4OH) of density 0.880 + 10g. ammonium chloride and made to 1 liter with distilled water) being in the center, and the anolyte (10g. ammonium carbonate, 20g. ammonium sulfate and 50cc. 0.880 NH_4OH made to 1 liter with distilled water) being in the two end compartments. The diaphragms are thin, porous tiles. Lead anodes are used. At 9 amp./sq. ft., 2.45v. is required for an electrode spacing of 25 cm. For a soln. containing 15g. Pd at 3° C, 1-4.5 amp./sq. ft., the cathode efficiency is 93-94%; 70° C, 18.5 amp./sq. ft., cathode efficiency 100%. The low temp. deposits are brightest. Concentrated ammonia is added to the anolyte at intervals to prevent the formation of explosive nitrogen trichloride, and part of the anolyte is periodically removed to evacuate accumulated ammonium chloride. The catholyte pH fluctuates from 9 to 10, depending on the concentration of ammonium chloride and free ammonia. The Pd deposits are bright up to 0.00002 inch; thicker deposits are milky but suitable for polishing, while deposits up to 0.01 inch can be obtained by this process though they tend to be brittle. Other palladosammine salts (sulfate, carbonate, acetate, etc.) may be dissolved in ammonia to form catholytes which give good, adherent deposits. The applicability of this process to the deposition of other metals, e.g., Cu,Co,Fe and Sn, is noted. Alloys of Pd with copper,

nickel, cobalt and iron have been deposited, but the process is not suitable for the deposition of alloys of Pd with platinum, iridium or rhodium. The properties of deposited Pd are given. Corrosion tests show that a minimum thickness of 0.0002 inch Pd is required to give freedom from porosity and entirely protect the basis metal from corrosion. Ni is a more satisfactory basis metal than Cu from a corrosion-resisting standpoint, but is not so easily covered with Pd: Ag is the most satisfactory basis metal.

C. A. **27**, 3143 (1933.) EDWARD B. SANIGAR

The effect of mercury in zinc cyanide plating solutions. E. E. HALLS. *Metal Industry* (*London*), **42**, 261 (1933.)—Zinc deposited with amalgamated Zn electrodes is equal, under mild corrosive conditions, and superior, under severe conditions, to deposits of the same thickness of Zn plate from ordinary processes. Disadvantages of the process are the dark color of the deposit and the high c.d. (40-50 amp./sq.ft.) required.

C. A. **27**, 3144 (1933.) ALLEN S. SMITH

The Electrodeposition of iron-cobalt alloys. Part I. S. GLASSTONE and J. C. SPEAKMAN. *Trans. Faraday Soc.*, **28**, 733 (1932.)—A study of the influence of hydrogen-ion concentration, c.d., dilution and stirring on the composition of Fe-Co alloys deposited from various solns. of iron and cobalt sulfates at 16° C. Current efficiencies for metal deposition were irregular and less reproducible than for cobalt-nickel alloys. An increase in c.d. and pH tends to increase the efficiency. The deposits were not good: alloys rich in cobalt were generally brighter and smoother than those rich in iron. Alloys deposited at low c.d. contain a greater proportion of cobalt than do the electrolytes. As the c.d. is increased, the proportion of iron in the deposit increases, rapidly at first, until a maximum is reached. The composition of the maximum deposit is independent of the soln. pH, and it contains a greater proportion of iron than the electrolyte. A general review of the results obtained in studies of the deposition of iron-cobalt, iron-nickel and cobalt-nickel alloys is presented. *C. A.* **27**, 910 (1933.) E. G. VANDEN BOSCHE. **Part II.** *Trans. Faraday Soc.*, **29**, 426 (1933.)—The variation with c.d. of the composition of the alloys deposited from buffered solns. containing various proportions of ferrous sulfate and cobalt sulfate has been studied at 50° C. and 90° C. The compositions of the alloys were found to tend toward a constant value as the c.d. was increased, which value appeared independent of the soln. pH. A comparison is made of the 3 series of alloys falling into the natural order iron-cobalt, iron-nickel and cobalt-nickel. The alloys deposited at both low and high c.d.s. showed graduations in percentage compositions in harmony with this order. These results are similar to those reported in Part I. for 16° C. *C. A.* **27**, 2884 (1933.) EDWARD B. SANIGAR

A Chromium plating bath with the fluoride ion. ALFRED PERLENFEIN. *Rensselaer Polytech. Inst. Bull., Eng. Sci. Ser.* **No. 39**, 36pp. (1933.)—Optimum plating conditions were obtained with 250g. chromic acid and 10g./l. sodium fluoride at 45° C. and 140—605 amp./sq.ft. Decreased concentration of sodium fluoride gave poor deposits, while at increased concentration above 10g./l. plating did not occur at low c.d. and only poorly at high c.d. Good deposits were obtained when using chromic acid concentra-

tions of 125—300g./l. In comparison with the sulfate bath, the fluoride bath gave brighter plate over a wider plating range. An impervious plate was made directly on iron with a c.d. of 288 amp./sq.ft.

(*C. A.*, **27**, 2884 (1933).

Absorption of colloids by metallic surfaces and its effect on the adherence of electrolytic deposits. P. JACQUET. *Compt. rend.* **196**, 921 (1933.)—The adherence of electrodeposited copper from copper sulfate solns. to a carefully cleaned copper cathode is greatly diminished if the cathode has been previously dipped into sols of certain colloids such as proteins and their degradation products, but it is not affected by dipping into other colloids such as gums and dextrin. The effort is due to an adsorbed layer of the effective colloids, which clings tenaciously even if the electrode is thoroughly washed in boiling water. The more concentrated the sol into which the electrode is dipped, the weaker the adherence of the electrodeposited copper. Examination of the deposited copper with the microscope reveals no difference between deposits on treated and untreated electrodes.

C. A., **27**, 2885 (1933.) F. L. BROWNE

The production of flawless chromium plate of lasting quality. P. HENTSCHEL. *Metallwaren-Ind. u. Galvano-Tech.*, **29**, 525 (1931.)—It was found that chromium plate deposited at a c.d. greater than 55 amp./sq.ft. disintegrated in concentrated nitric acid, while that deposited at 9—46 amp./sq.ft. was not destroyed even after the brass, upon which it had been plated, had completely dissolved.

C. A. **26**, 1196 (1932.) CURTIS L. WILSON

Cold chrome plating. W. KAMPSCHULTE. *Oberflaechentechnik* **10**, 86 (1933.)—Tests have shown that chromium deposited at 38° C. were much more resistant and adhered much more firmly than those made at 20° C.

C. A., **27**, 2626 (1933.) M. HARTENHEIM

A new modification of electrolytically deposited chromium. B. RASSOW and L. WOLF. *Angew. Chem.*, **46**, 141 (1933)—A preliminary report. By substituting for the commonly used sulfate radical catalyst in chromic acid baths a radical of one of the complex fluo-acids, a plate was obtained which protected the basis metal (copper and brass) against corrosion 5 times better. No satisfactory explanation has yet been found for this more compact plate. (See following note—E. B. S.)

C. A., **27**, 2626 (1933.) E. B. S.

Electrodeposition of chromium.—U. S. patent No. 1,844, 751, Feb. 9, 1932. COLIN G. FINK and HUGH D. McLEESE (to United Chromium, Inc.) A soln. is used containing chromic acid and such a quantity of fluosilicic acid as contains the same amount of fluorine as that contained in 10g./l. or less of chromium fluoride (CrF_3), for a soln. containing 250g./l. of chromic acid, and a proportionately higher or lower fluosilicic acid content for higher or lower chromic acid content.

C. A., **26**, 1865 (1932.) E. B. S.

Gold as protection against corrosion. R. LEONHARDT and P. STEEN. *Oberflaechentechnik* **10**, 83 (1933.)—Gold plate should be used only

where no great mechanical stresses are exerted. Articles of iron or steel can be very well protected by gold plating when nickel is applied as an undercoat. Gold is recommended for its resistance to oxidation, acids and alkalies. Its expansion coefficient is so close to that of nickel and iron that no cracks will form within wide temp. ranges. It adheres extremely well and does not peel. The best bath is the potassium cyanide bath. Temp. and c.d. should be low.

C. A., **27**, 2628 (1933.)

Cyanide zinc plating baths using the aluminum-mercury-zinc anode. A. K. GRAHAM. *Trans. Electrochem. Soc.*, **63**, 11pp. (preprint) (1933.)—The performance of the aluminum-mercury-zinc anode was studied in 1 *N* zinc cyanide baths at 20amp./sq.ft. and 49° C. The sodium cyanide was varied from 0.5 to 1.5 *N* and the caustic soda from 0 to 1.9 *N*. The current efficiencies, anode polarization, bath voltage, soln. maintenance and sludge formation were observed. The effect of sodium carbonate additions, of reducing the zinc cyanide concentration to 0.75 *N* and of substituting a pure zinc anode were also studied. Superior operating characteristics of the baths are found within certain recommended optimum concentration limits for both NaCN and NaOH. The 0.5% Al, 0.3% Hg—Zn anode operates satisfactorily in the baths studied and is sludge free.

C. A. **27**, 2385 (1933.) COLIN G. FINK

Cadmium plating.—U. S. patent No. 1,893,368, Jan. 3, 1933. GEO. B. HOGABOOM and MYRON B. DIGGIN (to Hanson-Van Winkle-Munning Co.) An oxyheterocyclic ring compound, such as hematein furfural or an alkali metal furoate or alkali furfural resin, is used in a cyanide cadmium-plating soln. in order to produce uniform, dense, bright coatings.

C. A., **27**, 2101 (1933.)

Defective electrolytic deposits of chromium. O. MACCHIA. *Industria chimica*, **7**, 275 (1932.)—The causes of unsatisfactory deposits from chromic acid baths containing sulfate are examined. Patchiness may result from dirt, etc., on the basis metal, or too low a c.d. especially in re-entrant parts, or from an excess of sulfate-ion in the bath. Partial or complete burning of the deposit may arise from excess of sulfate-ion or trivalent chromium-ion, or from excessive difference between the bath temp. and that of the object. The deposit may appear stained if there is insufficient sulfate-ion in the bath, if the object is not properly polished, or if the c.d. is too low. Subsequent flaking may be due to imperfect cleaning and polishing of the object, to the deposition of chromium on a unsuitable basis metal such as aluminum or zinc, or to the application of too thick a deposit.

C. A., **27**, 2386 (1933.) Brit. Chem. Abstracts

Alloys suitable for molds for electrodeposition.—British patent No. 368,412, Dec. 14, 1929. JEAN BILLITER. The alloys contain iron or chromium and 13-25% silicon, e.g., iron or chromium silicide.

C. A., **27**, 2101 (1933.)

Electrolytic precipitation of arsenic on brass, copper, etc.—Russian patent No. 27,546, Sept. 19, 1927. A. G. RODIONOV. The electrolyte consists of a soln. of arsenious acid and sodium and potassium chlorides.

C. A., **27**, 2101 (1933.)

BRANCH NEWS

CHICAGO BRANCH

Chicago Branch held its regular monthly meeting July 8th, at the Atlantic Hotel, President F. J. Hanlon presiding and all officers present.

It was decided owing to the warm night and there not many being present that we would wait until our August meeting to install our newly elected officers.

Delegates Servis, Gilbertson, made partial reports on the Convention and Convention Secretary, Tompkins, made a partial report on the results of the Convention.

Two new applications were received.

The Librarian found the following questions in the question box.

What is the best method for producing a blue color on steel, Copper plating or heat treating can not be used?

Answer—4 Oz. Hyposulphite of soda. 4 Oz. Acetate of lead. Use boiling and many color shades can be obtained on steel.

Chicago Branch held its regular monthly meeting Aug. 12, at the Atlantic Hotel.

President E. G. Stenberg presiding and all officers present.

Mr. R. Meyers, one of our Past Presidents, installed our new officers and impressed upon each officer the various duties required of him. After listening to a fine installation talk from Bob every officer cannot help but be inspired to make good in his office.

Mr. J. DeGrazio and Mr. Gilbertson acted as Marshalls.

It is with deep sympathy and regret that we report the following.

The Branch extends to Mr. J. Lockerbie deepest sympathy in the recent death of his wife and also his father.

And to Mrs. F. L. Greenwald and family in the death of our Past President of Chicago Branch, Fred L. Greenwald.

And to Mrs. F. J. Liscomb and family in the death of our beloved

MR. JOHN STERLING, *Secretary, New York Branch. Sends the following clipping from the* BERKSHIRE EAGLE.

CHARLES H. BUCHANAN, 75 years old, for 30 years a resident of Hinsdale, Mass., died at his home on South Street, at 9.30 P. M. July 24th, 1933. He had been in ill health for two years, but had been confined to his bed for only a week. He was born in Chicago, Ill., November 3rd, 1858. He spent most of his life in Brooklyn, N. Y. He was a salesman by profession, retiring about ten years ago, was a Charter member of the New York Branch of the American Electro-Platers' Society and on his retirement was made an honorary member. He is survived by his wife and one brother William of Los Angeles, Cal.

friend and brother, Fred J. Liscomb.

We hope and sincerely wish Mrs. Baine and family, Peace, in the loss of her husband. Don Baine although not a member of the Chicago Branch, was a very good friend of the A. E. S.

The Librarian found the following questions in the question box.

Question—What is a good non corrosive flux to be used to solder small steel brass plated articles?

Answer—Many different flux suggested but mainly neutralize by rinsing in water and drying off in a short time.

Question—Is there any advantage in plating steel parts for 5 minutes in a hot Nickel then for 15 minutes in a cold Nickel?

Answer—No advantage but considered very bad practice.

Question—Will Cadmium work stripped in the same solution as when plated cause a brown stain on the plated work?

Answer—Poor practice to strip in the same solution used to plate in. A little cyanide in the rinse water thought to be the cause of the stain. Rinse better. A good strip for Cad-

TEMPER COLORS FORMED ON POLISHED AND BUFFED STAINLESS STEEL

Composition of Steel not Chrome Plated			*Discoloration formed after 1 hour*			
Carb. %	*Chro.* %	*Nickel* %	392° F.	572° F.	752° F.	842° F.
0.09	16.0	0.34	No discoloration noticed	Straw	Bronze	Blue
0.10	20.4	0.30		Straw	Bronze	Blue-Bronze
0.10	24.4	0.37		Faint Straw	Dark Straw	Bronze
0.19	33.4	0.36		Faint Straw	Straw	Dark Straw
0.10	15.2	11.4		Straw	Bronze	Blue
0.12	18.0	8.2		Light Straw	Bronze	Blue

At low temperature, a polished surface of high chromium steel commences to color slightly at 550° F. or thereabouts. The higher the chromium content, the higher the temperature at which color becomes visible. The above tests were held in electrically heated muffle furnace.

Following test was made on 18.8 Stainless Steel with L. & N. Potentiometer Indicator used:

Polished and Buffed Not Chrome Plated	*Polished, Buffed and 2 Minutes Chrome Plated*
430° F. Slight tinge	770° F. Slight tinge
450° F. Slight tinge of straw color	810° F. Light tan
480-520° F. Richer straw color	840° F. Little darker tan
540° F. Light tan color	
575-600° F. Rich tan color	
650° F. Purple	
700° F. Deep blue	

A 2 minute Chrome Plate will prevent any discoloration up to 800° F.

mium can be made of Ammonia Nitrate about 1½ lb. Water 1 gal. use cold with reverse Current.

Question—What is a good strip for Nickel Plated Aluminum?

Answer—A regular bright dip is thought best.

Question—What is a good way to make an old iron effect on large zinc panels with glass in must not be lacquered?

Answer—Many different blacks suggested but black Nickel thought best.

Mr. O. E. Servis told of a new water dip water white lacquer now on the market for Cadmium plated work.

Mr. Gus. Jelinek showed a fine sample of soldering on Stainless Steel. Giving a talk on the method used to obtain same.

He also furnished a paper on Discoloring of Stainless Steel at higher temperatures giving a list of colors at various temperatures. Stating that a too minute chrome deposit on the Stainless Steel would prevent discoloring up to 800° Far.

J. W. Hanlon, *Secretary*

ANDERSON BRANCH

Regular monthly meeting held at the Guide Lamp Shack at 7.30 P. M., August 7th.

The meeting was called to order by President R. M. Wagner.

Roll call of officers showed Mr. Chaney absent.

The Minutes of the last meeting were read and approved.

A lengthy communication from the Associated Platers of Southern California was passed around relating to a Platers Code under N. R. A. No action taken.

Application for membership in the Anderson Branch was received from John R. Taylor. Application accepted.

A plan for clearing up delinquent accounts, as previously drawn up by the Board of Managers, was presented to the Branch for approval. By this plan all old accounts dating from July 1, 1933, are to be cancelled, new accounts to date from the first of the new fiscal year. This plan was accepted.

The new account forms were exhibited by the Treasurer, Mr. Onksen.

A Meeting of the Program Committee was called for this week to outline programs for the Fall and Winter meetings. Suggestions were received regarding the general nature of the programs. Messrs. Cleaver, Bonge and Minton volunteered to read abstracts from selected trade journals at the next meeting. Messrs. Cleaver, Castell and Minton appointed as a committee to select a group of current trade periodicals and publications for subscription by the Branch.

Messrs. Cleaver and Castell gave a very interesting resume of the transactions and papers presented at the recent Chicago Convention of the National Society. Mr. Fred Carl's paper on "The Photomicroscopic Determination of Plate Thickness on Steel, Brass and Die Castings" which he presented at the Convention was highly commended.

Meeting Adjourned.

G. M. Cole, *Secretary*

MILWAUKEE BRANCH

The regular meeting of Milwaukee Branch was held on Thursday, August 10, 1933, at Lipp's Hall. Vice-President Robt. W. Shaffer called the meeting to order. After a short business session the meeting was turned over to Librarian, Henry Binder, who took charge of the Educational session. The topic for our next Educational meeting is "Electric Pickle." The September meeting will be on Thursday, September 14, 1933.

Frank J. Marx, *Secy.-Treas.*

BRIDGEPORT BRANCH

On July 7th, the regular monthly meeting was held in the Chamber of Commerce rooms, Stratfield Hotel. President, Al. Rosenthal called the meeting to order.

The Sick Committee reported on the illness of Bill Stratton and the improvement of John Maher.

The report of June, 1932—May, 1933, was read and ordered placed on file.

The transfer of Mr. Sterling from the Chicago Branch to the Bridgeport Branch was accepted. Mr. Sterling invited the members to visit his department in the General Electric Co.

Treasurer's Report was read and accepted.

A motion was made to adjourn at 9.45 P. M.

WM. FLAHERTY, *Sec.-Treas.*

The regular monthly meeting of the Bridgeport Branch was held on August 4, in the Chamber of Commerce rooms at the Stratfield Hotel.

Plans were made for an outing to be held in Nichol's on September 23.

President, Al. Rosenthal will have full charge of the affair and make it an even greater success than in former years.

Reports were read and accepted and the meeting adjourned at 9.45 P. M.

WM. FLAHERTY, *Sec.-Treas.*

LOS ANGELES BRANCH

Minutes of the regular monthly meeting of Los Angeles Branch held June 14, 1933, at the Rosslyn Hotel. Vice-President, M. D. Rynkofs called the meeting ot order.

The newly elected officers were installed by Mr. M. McNulty.

Mr. Rynkofs withdrew as a delegate to the National Convention and was replaced by Mr. Coombes.

EXPERIENCED ELECTROPLATERS *prefer* ANACONDA *Copper Anodes*

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E. WAMBAUGH CO., Goshen, Ind.

The Branch voted to allow Mr. Coombes $25.00 to take care of his expenses at the Convention.

Bills for fourth quarter per capita tax, meeting notices and Secretary fee were read and ordered paid.

The meeting was cut short because of a meeting of shop owners scheduled to follow immediately after our meeting, and called to discuss the N. R. A.

EARL COFFIN, *Sec.-Treas.*

CLEVELAND BRANCH

The monthly meeting of the Cleveland Branch was held on August 5th, at the Carter Hotel.

The meeting was called to order by President, H. J. Ter Doest, the Minutes of previous meeting were read and approved. A letter was read from the Associated Electro-Platers' of Southern California with a copy of their Code of Fair Competition. This letter was turned over to one of our members, Mr. O. Berg, who is representing the Job Platers of this territory.

We regret to announce the resignation of Mr. Ben Hengst one of our old members.

The Report of the Supreme Secretary was read and approved as read. It was moved and seconded that the balance of our pledge be sent to the Reserve Fund. The Secretary was instructed to write some of our delinquent members. Mr. Thompson gave the Report of the Delegates to the Convention. After a little talk on the flow of current in solution, the meeting adjourned at 10.30.

W. D. SCOTT, *Secretary*

APPLICATIONS:

	Branch
John Robert Taylor, 310 Ohio St., Marion, Ind.	Anderson
Frederick J. Kaim, Lawson & Mackabin Sts., St. Paul, Minn.	Chicago
Hagen Thomsen, 2806 Altgeld St., Chicago, Ill.	Chicago
Robert E. Jackson, 2422 N. Mutter St., Philadelphia, Pa.	Philadelphia
C. C. Johnson, 1124 Kern St., Waterloo, Iowa	Chicago
E. W. Gorringe, 429½ Belden Ave., Chicago, Ill.	Chicago
Thomas H. Dobson, 766 S. Lee St., Des Plaines, Ill.	Chicago

ELECTIONS:

John R. Taylor, 310 Ohio St., Marion, Ind.	Anderson
F. J. Kaim, Lawson & Mackabin Sts., St. Paul, Minn. (Assoc.)	Chicago
Hagen Thomsen, 2806 Altgeld St., Chicago, Ill.	Chicago
R. E. Jackson, 2422 N. Mutter St., Philadelphia, Pa.	Philadelphia

REINSTATED:

	Branch
E. D. Bedwell	Los Angeles
Frank Shaw	Los Angeles
Chas. Waugh	Los Angeles

RESIGNATIONS:

Benjamin Hengst	Cleveland
B. Deakin	Toronto
V. D. Nash	Toronto
G. W. Randall	Chicago

DEATHS:

Frederick Greenwald	Chicago
Frederick Liscomb	Chicago
C. J. Bayer	Philadelphia
Robert E. Taylor	Toledo
Mrs. Bertha Bast	Toledo

SUSPENSIONS:

Edgar Freeman	Grand Rapids
Alfred Phillips	Grand Rapids
Chester Dykhuis	Grand Rapids
Earl C. Braden	Grand Rapids
E. Degreman	Grand Rapids
Albert Schauer	Grand Rapids
Gus. Gehrke	Milwaukee
Al. Gross	Milwaukee
H. C. Jaeger	Milwaukee
L. R. Bartnek	Chicago

SUSPENSIONS—Cont.

Martin B. Apy	New York
Wm. A. Betz	New York
John J. Burke	New York
N. E. Brewerton	New York
C. A. Cooper	New York
J. Dora	New York
E. Cohan	New York
John B. Figliozzi	New York
Vincent Fama	New York
B. H. Green	New York
William Horb	New York
Frank Klaus	New York
Joseph Kruta	New York
Louis Keller	New York
Frank Loeb	New York
Joseph Minges	New York
Fred Muschler	New York
I. Mersham	New York
A. Messano	New York
G. Mallow	New York
J. F. Nestor	New York
Joseph Pactzus	New York
Geo. M. Roberson	New York
Hermann Ruhlmann	New York
Joseph J. Triska	New York
Francis L. Macnamara	Philadelphia
M. C. Miller	Philadelphia
Anton Anderson	San Francisco
Frank Celentino	San Francisco
Clyde Nichols	San Francisco
W. Stuart Pankey	San Francisco
C. J. Ristero	San Francisco
H. S. Hardwick	San Francisco

McKeon's ***"Liquid Sulphur"*** is the oxidizing agent of today. Order on approval direct or specify by name through your jobber. Your money back if you want it! Sulphur Products Co., Greensburg, Pa. (Producers also of NATROLIN Metal Cleaner).

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